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THE APPLICATION OF ENGINEERING TO THE AGRICULTURAL INDUSTRY[1]

By HENRY GIESE

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IN a recent discussion of trends in business, Merle Thorpe, editor of *Nation's Business*, said that the first quarter of the twentieth century would probably be known as the age of mass production.

With the great industrial developments so immediately before our eyes it seems unnecessary to make further mention of them here. Rather it is our intention to speak regarding the progress which has been made in the agricultural field and the obligation of the engineer in helping it to keep pace with other enterprises. William M. Jardine, former secretary of agriculture, once said, "Could the farmer of the Pharaohs' time have been suddenly reincarnated and set down in our grandfather's wheat-field, he could have picked up the grain cradle and gone to work with a familiar tool at a perfectly familiar job." Imagine the amazement of the ancient Egyptian if he were to be set down in a present-day wheat-field with the combined harvester-thresher in full operation.

Less than a century ago more than 90 per cent. of our total population were directly dependent upon agriculture for a livelihood. In 1928, with fewer than 24 per cent. directly dependent upon the industry, our nation produced a surplus of agricultural commodities. American agriculture may be said to have had three power epochs: (1) human, (2) animal, (3) mechanical. The change has brought not only a more efficient production but also a relief from the drudgery and monotony which doubtless contributed to the encouragement of slavery.

Mechanization of agriculture has made the Ameri-

[1] Paper read before Section M—Engineering, American Association for the Advancement of Science, Des Moines, Iowa, December 30, 1929.

can farmer the most efficient farmer in the world. According to data compiled by the division of agricultural engineering, Bureau of Public Roads, U. S. Department of Agriculture, the estimated total primary horse-power available on farms increased from approximately seven millions in 1850 to nearly 47½ millions in 1924. The direct relationship between power used and the value of crops produced is strikingly shown in the following table.[2]

Country or state	Primary power per agricultural worker	Value of crops produced annually
Italy	.19	$ 45.00
France	.37	90.00
Germany	.55	119.00
United Kingdom	.88	126.00
Alabama	.81	112.00
New York	1.69	250.00
Indiana	2.46	365.00
Iowa	3.86	595.00
Nebraska	4.71	910.00

According to Davidson,[3] the United States exports rice in increasing amount to China. Here we have the extreme in contrasts; rice production in China by hand labor at a low wage, fifteen cents a day, and rice production in California by machine methods with the highest-priced agricultural labor in the country, or fifty to sixty cents an hour with "found." The Chinese laborer boards himself. Is it reasonable to believe that engineering will continue to contribute to the progress and development of agriculture? Engineering more than any other factor has enabled the American farmer to compete with foreign competitors. A few years ago several German scientists visited this country, and the outstanding feature of their report on American agriculture was the large production per worker.

Nevertheless, the increased production per worker in agriculture has not kept pace with that of many of the other industries, and the return to the individual worker has been a problem which has received the serious attention of our federal government. In the final analysis, the returns per worker are of greatest importance in establishing a stabilized situation. The American Farm Bureau Federation has adopted the slogan, "A higher standard of living on the farm and an income from the farm to pay the bill."

Davidson has expressed the relationship by the simple equation, $I = (S - C)\,Q$, in which I signifies the income, S the selling and C the cost price of the farm produce and Q the quantity produced. Obviously I can be increased by increasing S or Q or by decreasing C. S is difficult to control especially when agricultural products are produced on some six million farms. Competition is severe in agriculture since we have not only the competition of individuals in our own country but also a stimulation of production in other countries. Prices raised by legislative action are likely to be short lived as a relief measure. Increased prices are always followed by increased production and land prices. Increased production usually leads to overproduction, a glutted market and falling prices. An increase in the efficiency of production probably offers one of the most encouraging possibilities of increasing the income of the individual.

This through the decrease of C or the increase of Q in the formula becomes, or may become, very largely a problem for the agricultural engineer.

The primary function of the agricultural engineer is to determine, recommend and promote the best solutions of engineering problems peculiar to the agricultural industries. His responsibility is—through modern operating equipment and practices—to aid in developing higher efficiency and greater productive capacity, thus making agriculture more profitable, lifting the burden of drudgery from agricultural people and raising their standard of living. Recognizing this, the American Society of Agricultural Engineers, as the national organization representing the agricultural engineering profession, has adopted the following platform as a statement of its objectives and of the principles and policies governing its activities.

"Engineering is the science of controlling the forces and utilizing the materials of nature for the benefit of man, and the art of organizing and directing human activities in connection therewith." Agricultural engineering deals with the application of the fundamental branches of engineering to the specific conditions and requirements of agriculture as an industry, as a mode of life and as a field of applied science. Subdivided on the basis of engineering technique, it now embraces (1) power and machinery, including rural electrification, (2) buildings and other structures, including sanitation, materials of construction and equipment, and (3) land reclamation, including irrigation, drainage, soil erosion control and other forms of mechanical improvement of agricultural lands.

An agricultural engineer is one who has been trained in both engineering and agriculture with experience in combining the two, and who is qualified to develop, design, organize and direct engineering

[2] Taken from Bul. 1348—U. S. Department of Agriculture, p. 17.

[3] J. B. Davidson, "Agricultural Engineering," *Journal of Engineering Education*, New Series, Vol. XIX, No. 3, November, 1928.

work of or closely related to the agricultural industries.

Agricultural engineering is fostered by land-grant institutions. Thirty-seven of forty-eight agricultural colleges in the United States provide agricultural engineering training to five thousand agricultural students annually. Technical engineers for this field are trained in seventeen of these institutions. Research work in this field is conducted by 103 full-time workers in thirty-four institutions.

Farm Structures

According to the latest census figures, the American farmer maintains a total investment in farm buildings of $11,750,000,000. How much it would cost to replace these buildings at the present time would be difficult even to guess. In order to maintain the buildings which he deems necessary for his farm, he spends several millions of dollars every day of the year. Unfortunately this money is often not well spent. Materials are frequently used where they are not at all suited, and sufficient consideration is not given to the actual requirements of the product housed.

With the recent agricultural depression the soundness of the farmer's investment has been seriously questioned, and since buildings appear to afford the easiest method of reducing his overhead, those in position to advise may have been guilty of preaching false economies in building construction. How many times has he been urged to reduce the cost of his buildings without due regard to the effect which this reduction might have on production or annual depreciation?

Industry buys equipment on a production cost basis. The ability of a given machine to bring returns is just as important a consideration as its original cost. A seemingly cheap machine may prove to be very expensive when its influence on production, labor, length of productive life and other factors are considered. Farm buildings constitute a part of the farmer's working equipment and deserve to be evaluated upon a production cost basis. The cost per quart of milk is more important than the cost per cow or the cost per barn. This attitude does not infer that we should neglect beauty or harmony in design, which have a very direct bearing upon morale, but that the emphasis should be put upon the securing of lower production costs by giving attention to management and fundamental housing requirements. The manner in which the farm building problem is handled is reflected in labor of operation, the quantity and quality of production and, in the case of stored products, the preservation for future needs.

One of the serious problems for farm management is that of labor. I am told that this is particularly true in the dairy industry. Recent studies show that the labor involved in dairying may be increased upwards of 30 per cent. by faulty arrangement of the barn and its relation to the other buildings in the farmstead. Fortunately it costs no more to arrange a barn efficiently. Often the saving in labor alone may be as large as the entire charge which may be placed against the dairy cow for rental.

If one expects to make dairying profitable, can he afford to neglect to plan the layout of his farmstead to assure efficiency in the use of labor?

The dairy cow is a warm-blooded animal. She may be likened to an engine operating under a fairly constant temperature. Fuel burned within the body generates heat which tends to raise the body temperature. She is provided with certain automatic means which dissipate this heat in order to keep the body temperature constant. Heat is radiated from the body surfaces. Moisture evaporated from the skin and thrown off by respiration carries off relatively large quantities of heat and helps keep the body temperature down. The rate at which this process goes on depends very largely upon the environmental conditions of air temperature, relative humidity and rate of air movement. If their combined effect is greater than the normal heat production of the body, more fuel must be consumed or body tissues destroyed to maintain comfort.

Experienced dairymen say that stable temperatures affect milk flow, and a cold spell may reduce the production by 5 per cent. or more. This reduction is frequently not temporary but continues throughout the current lactation period. Heavy feeding may prevent this reduction but is in itself an additional expense.

When it is considered that the total charge against the cow for housing is usually less than 10 per cent. of the total cost of producing milk, it may readily be seen that any attempt to reduce the cost of barn construction below the point where it satisfies the housing requirements may increase other cost factors more than is saved in building.

One might elaborate to show how buildings may affect returns in other lines. Egg production reflects the comfort of the birds. Grains are matured and preserved, horticultural products are kept in prime condition and the marketing period materially extended by proper housing. Whether it be housing live stock, grains, fruits or vegetables, there are definite requirements placed upon the building by the product itself which must be met if the building is to fulfil its obligation to the farmer. In general, these problems relate to the efficiency of operation, the

maintenance of effective production and the preservation or conservation of farm products.

Unfortunately, many of the fundamental housing requirements are not definitely understood. The importance of the building has not been fully appreciated. The small, scattered units have not attracted sufficient competent study. The comparatively long life of the buildings tends to minimize interest in the study of the problem.

Buildings are frequently constructed of materials produced on the farm or purchased in a semi-fabricated condition. More careful attention is then required than would be necessary in the case of machinery which has been manufactured and assembled by specialists and comes to the farmer all ready for operation. If the farm housing problem is to be solved in a way that will bring commensurate returns and constitute an investment rather than a liability, it is necessary that there should be a careful analysis of building methods.

The three major factors of design, construction and maintenance claim our attention. Utility being paramount, we should know definitely the requirements placed upon the building by the products housed. What environmental conditions does the dairy cow need in order to produce milk most efficiently? How can we house the hen so that she will lay eggs when egg prices are favorable? Is ventilation necessary, and if so, how can it best be accomplished? What are the sanitary requirements for producing clean milk and maintaining a healthy herd? What insulation is advisable? How can the building be constructed most effectively and economically?

While it may be difficult to put a cash value upon beauty and harmony, they are very important items in maintaining a wholesome atmosphere on the farm. How can the farmstead be made attractive without adding unduly to the cost?

Methods of construction should be carefully studied in order to obtain a building which will provide these requirements at a minimum cost.

The influence of destructive agencies must be understood if we are to build in a way which will lower the depreciation cost.

Since little information is now available, the solution of these questions calls for an extensive research program. Evidently the farmer as an individual can not conduct his own researches efficiently. The small units and scattered field have not been generally profitable to the architect, and the farmer will not usually employ professional service. A program of this kind is logically the responsibility of publicly supported agencies such as the land grant colleges and the U. S. Department of Agriculture.

Power and Machinery

The agricultural industry is a tremendous user of power. However, the nearly 50,000,000 horse-power available is not being utilized to its greatest efficiency. Engineering attention is necessary if we are to secure lower production costs through the more economical use of power. Farm equipment design and the mechanization of farm operations now done by hand offer possibilities which challenge the best effort. There has been great progress in the harvesting machinery, but much still remains to be done. The use of electricity as an agricultural power has gained considerable prominence recently. Much investigational work is now being conducted to find the most practical methods of using electrical equipment.

Land Reclamation

The agricultural engineer is interested in the improvement of land in so far as such improvement leads to lower cost of production. At the present time this means chiefly the improvement of land already being cultivated. Often economical cultivation is prevented by wet spots, open ditches, stumps or other conditions that prevent effective tillage or occupy land that otherwise could be cultivated.

Five types of problems are included: protection against stream overflow, drainage of wet land, irrigation of dry land, control of soil erosion, clearing of land obstructed by stumps or stones.

The agricultural engineer, as the term implies, is active primarily in the engineering relationships of agriculture. That engineering has had a profound and far-reaching influence on many of the developments in agriculture, especially during the past twenty years, is widely recognized. Engineering has been responsible, in a large measure, for creating a situation in agriculture comparable to that in manufacturing fifty years ago, when great industrial development in America had its real beginning. The evolution now going on in the agricultural industries emphasizes the importance of the engineering relationships and the increasing engineering responsibilities. The American Society of Agricultural Engineers therefore has pledged its activities to the further development and strengthening of the engineering relationships in agriculture and to the adaptation of the science and art of engineering to agriculture, to the end that the people engaged in farming may have increasingly better means for achieving a more stable prosperity and higher standards of living.

THE GOVERNMENT MAPPING PROGRAM IN A MAP-MINDED AGE[1]

By Professor J. S. DODDS

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NOT so many years ago a traveler going from one city to another pulled up his horses and asked the way whenever he became the least bit uncertain about the road. To-day a young man driving from one seacoast to another looks at his map of the airway as he passes over city after city without stopping except to refuel.

Can you imagine this present-day driver stopping to ask the way?

Whether in the air or on the highways or even on the water this motor-carried people uses maps as an aid to fast, sure travel.

Of course maps have been used and made by adventurers of all ages since first recorded history. There was a wonderful collection of maps in the library of Alexandria three thousand years ago. There are some fine examples of early cadastral maps on clay tablets in the British Museum which are more than four thousand years old. About six thousand years ago maps were made in Babylonia for taxation purposes.

These early maps were used mainly by explorers and scientists, but long before that time rude sketches on bark or sand or in mud or on walls were used by savages to convey ideas. It is this fact, that the untutored mind grasps ideas when presented in map form, which makes the maps of to-day so widely useful. They are still easily understood by all degrees of mentality. Even a four-year-old can learn facts from maps before she can read words.

No one can name all the present-day uses of maps. I quote from Colonel Robert R. McCormick, editor of the Chicago *Tribune*, to illustrate the general appreciation of the value of maps to-day.

A HUNDRED THOUSAND MEN COULDN'T HAVE GIVEN US WHAT THE MAP SHOWED INSTANTLY

In the late war, we often had to fire on batteries hidden by hills and screened overhead by timber growth. A hundred thousand men and millions of shells couldn't have won us the chance to see that battery and adjust our fire. But a pin prick in a good map—a little figuring with ruler and pencil—and we commenced dropping shells on the battery!

A proposition comes up to establish a new highway, barge line or air route. I might spend weeks plowing through books or visiting along the route, before I could form an opinion on it. But let me look at a few good maps showing physical features and economic resources along the route, and I can form a sound initial judgment as to prospects for success. The map has told me what I might have to send a dozen men to see.

Distance—intervening mountains or oceans—obstacles of time and space that would block the efforts of a thousand men to see—all these are swept away when you consult a good map.

You have the vision of thousands of aviators, scattered over thousands of miles, condensed on a single sheet. You can travel here and there—thousands of miles—in a fraction of a second. There before your eyes are the facts you want, without any non-essentials or obstacles obscuring your vision. And you can point out and prove to others instantly what you scarcely could hope to show in any other way.

For accurate grasp of facts—for a quick road to sound decisions—for solving a multitude of problems in business, politics and pursuits of pleasure, I say: *Give me first a good map.*

This testimonial to the value of maps is just a sample of the present-day appreciation of maps.

Maps are used to illustrate the day's news. If Byrd flies over the North or the South Pole, his course is shown by a clear sketch map. Each week during the construction season the papers publish a progress map showing road conditions in our states. The location of detours and various road types is shown. No news story of a shooting or an automobile wreck or a fire is complete without its map with a cross marking the exact spot. The maps used in news stories are usually what might be termed sketch or outline maps.

Better maps drawn to a larger scale are used by travelers. It is a very common sight to see people passing along the highways sure of the way because alongside the driver sits another person watching the road map. This form of back-seat driving is approved.

Similar maps are used in aeronautics. Air navigation maps are made in strips showing the country along the flight course and for about eighty miles of width. They show all features of interest to the aviator, such as elevations of land, rivers, railroads, highways, cities and towns, landing fields, magnetic declination, and obstructions to flying such as transmission lines. In passing it may be said that these maps are compiled from such sources as are available and are far from adequate in many respects.

Similar maps are used by business executives in

[1] Paper presented before Section M—Engineering, American Association for the Advancement of Science, Des Moines, Iowa, December 30, 1929.

planning and executing sales campaigns. For such purposes outline maps showing various statistical matter are also used.

Maps are popular to-day with interior decorators. They are hung on the living-room walls. The type of maps used for this purpose might be called the illuminated map. You have seen them with ships on the ocean and fish looking out of the water and deer and bears in the woods and Indians and horses and cattle in view. Such maps are pictorial in character. This style map is also used in advertising to induce the traveler or sportsman to take an interest in the advertised region or product.

Newspapers take advantage of the wide-spread interest in maps by holding contests such as one recently put on by a Chicago paper for suggested new arrangement of the state boundaries to secure more equitable representation in the United States Senate. The author of this paper recently received a check for $100 for submitting such a map in the contest mentioned. The thousands of maps entered in that contest indicate the very general appreciation of maps.

The uses suggested so far in this paper, and only a very few have been listed, relate to a relatively low-grade or sketchy style of map. The purpose has been to show the wide-spread use of maps.

We now come to the specific uses of accurately made maps, maps prepared by engineers and used by engineers in their various enterprises. These uses will be considered in connection with a discussion of the various mapping agencies of the government and a brief review of mapping methods and the mapping program.

At this point it is well to mention that numerous agencies besides the federal government are in the business of preparing maps. These include various commercial map-selling organizations, state and local engineering organizations and the engineering forces of various industrial organizations. There is much evidence that the duplication of effort by these widely scattered mapping agencies, if saved, would more than pay for a well-considered governmental mapping program. It is also certain that if this wide diversity of mapping interests could know about and use all available mapping data, still more waste could be eliminated and money and time saved.

The following governmental agencies at Washington are users of maps: the Board of Surveys and Maps; Geographic Section Department of State; War Department—the General Staff M. I. D., Geographic Branch, Q. M. Corps, Construction Service, Chief of Engineers, Map Files, Intelligence Section, Reproduction Plant, Mississippi River Commission, Lake Survey, Air Corps, Bureau of Insular Affairs; Post Office—Topography Division; Navy—Hydrographic Office, Yards and Docks; Interior—General Land Office, Indian Service, Geological Survey, Reclamation Bureau, Park Service; Agriculture—Weather Bureau, Forest Service, Bureau of Chemistry and Soils, Soil Surveys, Biological Survey, Bureau of Public Roads, Division of Agricultural Engineering; Commerce—Aeronautics Branch, Bureau of Census Geographic Section, Foreign and Domestic Commerce Geographic Section, Coast and Geodetic Survey; also the Library of Congress; Government Printing Office, Superintendent of Documents; Interstate Commerce Commission, Map Section, Valuation, Land Section; International Boundary Commission, Canada; Federal Power Commission; Public Buildings and Public Parks; Pan American Union; District of Columbia, Assessor, Surveyor's Office, Public Library. The engineering forces of most of these governmental agencies are busy most of the time preparing and using accurate maps for specific purposes. It is the function of the Board of Surveys and Maps to correlate the various mapping activities to prevent overlapping and to eliminate waste by making the maps of each agency available to all the others. A complete topographic map of the United States is one of the crying needs of this generation, as most engineers know.

The federal government has been at work on a complete topographic map of territorial United States for more than fifty years. At the end of the last fiscal year, June 30, 1929, 43.6 per cent. of the United States had been mapped; 17,333 square miles were mapped during the year. There remains to be surveyed about 1,717,000 square miles of unmapped territory, and much of what was previously mapped is not up to standard. It is easy to see that at the present rate we can wait at least one hundred years for the completion of this mapping program. But the mapping program does not contemplate waiting one hundred years. Some years ago the Temple Act was passed which set twenty-five years as the limit. Several of those years have passed with no speeding up of the program. Now comes an administration familiar with the uses of and needs for topographic maps and insists on a program which if carried out will complete the topographic map according to present standards in eighteen years. The budget presented to Congress on December 4 by the president includes increased askings which have this eighteen-year program definitely in mind.

The complete topographic map of the United States is the work of two governmental services aided by various cooperating forces. The U. S. Coast and Geodetic Survey is engaged in mapping the coastal areas and a precise skeleton of first- and second-order

triangulation and levels covering the interior. This work is briefly explained by Major Wm. Bowie, chief of the division of geodesy, U. S. Coast and Geodetic Survey:

An organization to survey the coasts of the United States was formed in the early part of the nineteenth century and has, with only a short break, been in continuous existence. It was first called the "Coast Survey" and its activities were confined to the survey of the coast itself, the waters adjacent thereto and the small strip of land, a mile or two in width, extending back from the coast. All classes of work were done which were necessary for the construction of hydrographic or sailing charts. These classes consisted of the determination of latitude, longitude and aximuth, by observations on the stars, the measurements of base lines for the control of lengths of triangulation, triangulation extending from one astronomic station to the other, topographic surveys, hydrographic surveys to show the depths of the water, tidal observations, the direction and force of currents in tidal waters and determinations of the variation of the compass.

At first the Coast Survey operated only on the gulf and the Atlantic coasts, but shortly after the Mexican War, when California was added to our area, operations began on the Pacific coast. Shortly after the middle of the past century it was found desirable to connect the surveys of the Atlantic and the Pacific coasts by an arc of triangulation in order that the hydrographic charts could be placed in their proper relation with respect to their initial meridian and the equator. This arc of interior work, which was completed about 1895, was found to be of so great a value to surveyors and other engineers in the interior of the country that the name of the organization was changed to that of Coast and Geodetic Survey and its functions were enlarged so that the bureau's work would cover the execution of control surveys throughout the country.

The interior control surveys, triangulation or leveling, executed by the Coast and Geodetic Survey, are rated as first and second order. The first-order triangulation is of such accuracy that the closing errors of the triangles are approximately one second on an average, with about three seconds maximum closing error. Distances can be carried across country, by first-order triangulation, with an error not above one part in 200,000.

Second-order triangulation has closing errors which average about two seconds with a maximum closing error of about five seconds. Distances can be carried across country by second-order triangulation with errors seldom greater than about one part in 100,000.

First-order leveling, the most accurate used, has corrections of less than 0.15 mm per kilometer to close circuits. As a matter of fact, the average correction per kilometer is about 0.11 mm. This average correction is equivalent to 0.0006 feet per mile.

The Coast and Geodetic Survey is working towards the plan of having first- or second-order triangulation and leveling spread over the country to such an extent that the lines of leveling and arcs of triangulation will be spaced about 50 miles apart. The triangulation will be rigidly adjusted and final positions given to the several stations. The leveling also will be adjusted into the continental net, and the elevations furnished to the engineer will be referred to mean sea-level and will be standard or final. Intermediate areas will be filled in with control data by the U. S. Geological Survey.

The Coast and Geodetic Survey has a great spirit of loyalty among its personnel and a remarkable record for accuracy and scientific accomplishment. The topographic map itself is made in sheets of convenient size covering fifteen minutes of arc in latitude and longitude, or about thirteen miles by seventeen miles in this latitude, and made to a scale of one inch to one mile, or one to 62,500, and showing contours at twenty feet intervals. The surveys are made and maps prepared by the U. S. Geological Survey. The work is of a lower order than the network of first- and second-order surveys. The field work is carried on with great speed and efficiency.

Some of the earlier maps are now out of date on account of many natural and artificial changes in the surface features of the mapped areas. Many of these sheets were prepared in cooperation with local and state agencies and according to slightly varying standards, depending upon the purpose in the minds of the cooperating authorities.

It is now proposed to bring those sheets, which are obsolete, up to date and to map completely the remaining area without state or local aid except in cases where special conditions require expenditures in excess of the cost of the standard topographic sheets. These sheets are made according to standard regulations, and while they do not show 100 per cent. detail like a photographic mosaic, they do show surface conditions as engineers are accustomed to show them on maps of such a scale. Aerial photographs are now used as an aid in filling in topographical details. The air corps has cooperated in furnishing these.

In addition to the standard maps, special forms are prepared for individual purposes. For example, maps have been prepared of swampy regions in Florida and Wisconsin from aerial photographs showing all surface features but without contours. In 1928 a shaded relief and highway map of New Hampshire was compiled.

Other sheets have been prepared in cooperation with cities to show complete details to a large scale for use in city and regional planning or tax assessment work.

Strip maps have been made of areas connecting

certain distant points. These maps show all features of importance in a study to determine the most feasible route between terminals. The route may be for a railroad, highway, canal or transmission line.

Taken as a whole, the topographic maps are of major importance in planning engineering projects and securing their efficient and economic operation. These projects include tunnels, bridges, city surveys and planning, highway development and extension, irrigation projects, hydroelectric developments, improvement of rivers for navigation, flood control of rivers and general topographic surveying and mapping where a knowledge of elevations and geographic positions is required. In fact, there is scarcely any human activity of an extensive nature that does not need for its proper execution a very accurate knowledge of the elevation and slope of the ground and the accurate distances between points.

All these activities are customarily started with a survey and the production of a map or maps. With a topographic map available any such project can be started without the expense of preliminary surveys. Any details needing amplification can be quickly and economically added to the standard sheets or to photostatic enlargements by taking them into the field as a plane table sheet or by comparing them with a set of quickly secured aerial photographs.

Paper locations are rapidly and economically made on standard topographic maps, and safe preliminary estimates are easily made therefrom. Such maps disclose valuable information to the geologist, mining engineer, soil surveyor, regional planner, valuation engineer, forester, realty appraiser, hydraulic engineer and practically all the fifty-seven varieties of engineers who practice "the science and art of directing the application of the science of mechanics in the economic utilization of the forces and materials of nature."

The government mapping program contemplates making such a standard topographic map available for the whole territorial United States in less than two decades. This is a consummation devoutly desired and urged by engineers and engineering societies throughout the country for many years. We can not afford to be without it. As Major Bowie says, "A large paper could be written on the use of surveying and mapping to eliminate waste in industry."

The estimated cost of this program is $5,000,000 for the control surveys and $50,000, 000 for the mapping, or about one fifth of what the United States expects to save on naval expenditures by participation in the London conference.

The following states are completely mapped: Connecticut, Delaware, Maryland, Massachusetts, New Jersey, New York, Ohio, Rhode Island, West Virginia and the District of Columbia. These states have shown their appreciation of the topographic map by furnishing funds to insure completion.

The European countries are ahead of us in the matter of map appreciation. This is probably due to the importance of maps in connection with wars and the tourist trade, apparently the two principal occupations of much of Europe. Those who travel must know their Baedeker. Those who fight must have maps to plan their campaigns. The close-knit European countries have long been completely mapped, but you will note that the more thickly populated of our states are also mapped.

The writer wants to interject a thought here that for present-day needs it may be desirable to raise the standards of the topographic sheets to provide a larger-scale map with perhaps five-foot contours and still greater accuracy of detail. It is a fact that the present standard map, while of almost incalculable value, is nevertheless on such a small scale as to be in effect practically a sketch.

It may be that with the advantages of present-day aerial methods the same estimated expenditures will provide a higher standard for future maps with a resulting greater usefulness and further elimination of waste.

We are living in an age when maps are a basic need. Our engineers have long appreciated the value of good maps. It looks as if our government had reached the stage when it too realized the importance of maps in the economical conduct of affairs.

If Congress carries out the provisions of the Temple Act we will have in the next eighteen years a complete topographic map of the United States at a cost of less than a tenth of our annual expenditure for the military establishment or one tenth of the special appropriation for new cruisers.

OBITUARY

JAMES ARTHUR HARRIS

JAMES ARTHUR HARRIS died at Minneapolis, on April 24, following an operation for appendicitis. He was born on September 20, 1880, at Plantsville, Athens County, Ohio, son of Jordan Thomas and Ida Ellen (Lambert) Harris. His parents having moved to Kansas he entered the university at Lawrence and graduated there with the degree of A.B. in 1901. Going to St. Louis, he was botanical assistant at the Missouri Botanic Garden from 1901 to 1903 (working in the summers at Lawrence) and librarian of the garden from 1904 to 1907. Meanwhile he had taken

his Ph.D. degree at Washington University. From 1903 to 1907 he was instructor in general biology there. In the latter year he became investigator at the Station for Experimental Evolution (Carnegie Institution of Washington) at Cold Spring Harbor, Long Island, and continued there for seventeen years. In 1924 he was called to the chair of botany at the University of Minnesota where, as head of the department, he developed it in masterly fashion.

From the time of his attachment to the Carnegie Institution, Harris spent some time in other institutions and in the field. During 1908–09 he studied biometry under Karl Pearson at London. In the winters of 1912–13 he worked at the Desert Laboratory, Tucson, of the institution, and thereafter spent winter months at Tucson, at Jamaica, South Florida, and, in collaboration with the Bureau of Plant Industry, in the cotton experimental fields of the Southwest. This last work he continued after going to Minnesota. The Weldon medal and memorial prize of the University of Oxford were awarded to him in 1921.

Harris was one of the most industrious of investigators and prolific of writers in biology. Not infrequently he published fifteen or more papers in a single year. These covered a great range in detail, but fell into the following general classes: ecology, experimental evolution, biometry. His first paper, published in Kansas, 1900, was an annotated "Catalogue of the Crayfishes of Kansas," and this was followed by several papers on the crayfishes, culminating in his "Ecological Catalogue of the Crayfishes belonging to the genus Cambarius, 1903," which was, apparently, his doctor's thesis. In 1901 he published his first botanical paper ("Normal and Teratological Thorns of Gleditschia"). In 1903 he published on floral abnormalities and this topic interested him for many years; it led him particularly to consider the subject of variation in seeds in capsules. He became much interested in the pure-line theory and tested it out with beans. This led him to grow over a million seedlings. He discovered biotypes that had extra cotyledons.

A second series of papers grew out of his ecological interest. With R. A. Gortner he worked out a method of determining density of plant saps. This led to observations in the tropics and elsewhere and to the discovery of the greater sap density of parasitic plants over their host plants. It led to a study of the chemical differences in races of cottons corresponding to their morphological differences.

The third great interest of Harris was biometry. He had the statistician's love of numbers and he applied the Pearsonian methods to a great variety of animal and plant data, such as the egg laying of fowls, basal metabolism in man (with F. G. Benedict), and seedlings of the bean. His biometric work led him to work out new formulae of which many are of particular interest to geneticists.

Through all of Harris's work runs evidence of his interest in problems of evolution. He published not only on organisms in relation to environment, but also repeatedly on natural selection and on assortative mating (in man).

Of the personal traits shown by Dr. Harris, unlimited industry is one of the most striking. He never spared himself, and on one occasion when the nature of his research demanded continuous observation he worked during the midnight and early morning hours throughout the winter. He organized a biometric laboratory at Cold Spring Harbor and supervised the work of a large corps of assistants. In the field his energy was boundless. At Minneapolis he catalyzed a somewhat dormant botanical group, so that his department soon rose to a high rank. Harris had remarkable social traits. He inspired loyalty in his associates in the laboratory and in the field. His hospitality, with that of Mrs. Harris, was unbounded, and their home was the center of many social meetings of his associates. He was particularly happy in his married life. Mrs. Harris (Emma Lay) was also a naturalist. They had four sons in whom the family traits will, we feel sure, be continued. But the numerous societies in which he participated, often as officer, will miss him sorely. The loss brought by his death to his scientific associates will be only second to that suffered by his family.

C. B. DAVENPORT

RECENT DEATHS

DR. ALLERTON SEWARD CUSHMAN, chemist and founder of the Institute of Industrial Research in Washington, died on May 1, at the age of sixty-two years.

DR. CHARLES FRANCIS MCKENNA, consulting chemist of New York City, died on April 25, at the age of sixty-nine years.

MEMORIALS

A CENTENNIAL anniversary dinner in memory of the late Dr. Abraham Jacobi, who was born on May 6, 1830, and died on July 10, 1919, was held on May 2 at the New York Academy of Medicine. Professor Franz Boas, of Columbia University, was chairman of the committee of arrangements. The speakers announced were Dr. J. A. Hartwell, Dr. William H. Welch, Dr. Fielding Garrison, Miss Lillian Wald and Mr. George McAneny. Dr. Mary Putnam Jacobi, widow of Dr. Jacobi, was expected to attend. Dr. Jacobi became in 1860 the first professor in America of diseases of children, a subject which he taught for nearly fifty years.

A TABLET in memory of Dr. John E. Sweet, professor of mechanical engineering at Cornell University from 1872 to 1879, was unveiled on April 5 at the Engineers' Club, New York. The tablet is the gift of the American Society of Mechanical Engineers in tribute to one of its founders and presidents. Dr. Sweet, who died May 8, 1916, was the inventor of the straight-line engine and, at the time of his death, one of the most widely known mechanical engineers in the United States.

SCIENTIFIC EVENTS

EXHIBIT OF WEIGHTS AND MEASURES AT THE SOUTH KENSINGTON MUSEUM

A NEW and permanent exhibition has been opened at the Science Museum, South Kensington, to illustrate the historical development of standards of weights and measurement. The London *Times* states that the exhibit occupies the whole of the entrance hall facing Imperial Institute Road and the long ground-floor gallery which leads into it. In the vestibule is a series of instruments arranged to display the principles of the equal-arm balance, the steel-yard and the more complicated recent mechanisms which extend the applications of the lever principle.

The earliest exhibit is an authentic Egyptian equal-arm balance of 1350 B. C., with a wooden beam and a cord pivot suspension, such as is still used in the bazaars of India and in China. One of the original stone weights accompanies it. A Roman bronze balance and steel-yard are shown (both in replica), and a number of glass weight standards of the Early Middle Ages. The methods of suspension by cord, by the less accurate ring device, by the gallows-and-pin, and by the knife-edge are shown both in the working specimens and in a series of transparencies in the adjoining gallery, while a number of skeleton models designed by Mr. W. A. Benton, of the Avery Historical Museum in Birmingham, display upon a small scale the various improvements made within the last few centuries to allow large weights to be measured with great speed and accuracy.

Certain turning-points, such as the Roberval "static enigma" of 1669 and Wyatt's cart-weigher of 1740, have affected the whole of modern practice in large-scale weighing machines, but though the models of these are interesting more attention perhaps will be drawn by Mr. Benton's reconstruction of the two self-indicating balances designed by Leonardo da Vinci in a manuscript now in the Bibliothèque Nationale.

The companion collection of instruments of measurement is of more recent date, since the invention of the micrometer can not well be traced beyond William Gascoigne's micrometer designed in 1639 for astronomical purposes. Important instruments such as Watt's eighteenth-century micrometer, Whitworth's measuring machine of 1855 (the first to indicate a millionth of an inch) and the comparators recently developed by the National Physical Laboratory through the use of a beam of light, can be seen and demonstrated in the gallery. Three important standards of length lent by the Royal Society are Graham's standard yard of 1742, Bird's standard 90 inches of 1750 and Shuckburgh's 5 ft. standard of 1796. It was by the use of these that the Standards Commission of 1843–55 was able to connect the standards now in use with the Elizabethan yard, after the destruction of the Imperial standard in the 1834 fire at the Houses of Parliament.

THE PROPOSED MEDICAL CENTER IN BROOKLYN

AT the semi-centennial dinner of the Alumni Association of the Medical School of the Long Island College Hospital plans were announced on April 26 for the establishment of a medical center in Brooklyn, N. Y. The plan, which includes separation of the Long Island College Hospital from its Medical School, calls for the organization of a new medical college to be associated with nine Brooklyn hospitals. The physical equipment of the combined units will cost more than $100,000,000.

The new institution, for which a board of trustees has already been chosen, will apply shortly for a charter as a medical college. It has voted the first $500,000 toward an endowment fund to meet the educational law requirements for the organization of a collegiate institution in New York State.

Dr. James C. Egbert, president of the medical school that is being discontinued, is a member of the board of trustees of the new institution.

The plans for the college include the erection of a central building which will be located in mid-Brooklyn and which will be easily accessible to the hospitals involved in the plan. The site has already been selected. The building which is to be erected within the next five years will cost, according to an estimate made by Dr. Egbert, more than $3,000,000. The plans of the board also call for an immediate endowment fund of at least $1,000,000.

The central plant and its affiliated hospitals will take care of at least 400 medical students. Courses in the first two years will be given at the central building. In the last two years students will receive in-

truction at the central plant and at the affiliated hospitals.

Of these hospitals four will have intimate contact with the college and be represented on its board. They are the Brooklyn, Methodist Episcopal, Jewish, and the Long Island College Hospital. The present teaching arrangements with the city hospitals in Brooklyn, including use of clinical material by the third and fourth-year students, will be maintained.

THE SUMMER MEETING OF THE SOUTHERN DIVISION OF THE AMERICAN PHYTOPATHOLOGICAL SOCIETY

THE Southern Division of the American Phytopathological Society will hold its annual summer meeting from June 11 to 16. The arrangements for the field tour are under the direction of Dr. L. E. Miles, *chairman*, and L. M. Fenner, *secretary*. The group will assemble at the Walthall Hotel in Jackson, Mississippi, during the evening of June 11. On June 12, an early departure will be made southward to the truck crop areas around Crystal Springs and Hazlehurst. This is the center of the fresh tomato district. Field operations, grading and packing may be observed. Tomato shipments will be at the peak. In the field, observations are being made on the overwintering of bacterial canker of tomato and other tomato diseases. Diseases of beans, carrots, cotton and sweet potatoes will be noted here and in the coastal area. Search is being made for the newly discovered phony peach disease. Departing from the famous health resort at Browns Wells on June 13, visits to pecan groves and nurseries will be made, and the work of the South Mississippi Experiment Station at Poplarville will be noted. Citrus, figs, grapes, peaches, sugar cane and gladiolus will be of interest here. From Hattiesburg on June 14, the tour will include diseases of citrus, pecans and sugar cane, arriving in Biloxi late that afternoon. Visits to truck crop areas, nurseries and to the pecan station will be made on June 16.

For members interested in the collecting of fungi, this tour should afford an opportunity for gathering unusual specimens. The winter and spring seasons have been cool and rainy over much of the state and the conditions may favor a considerable number of plant diseases.

The State Plant Board of Mississippi and the Agricultural Experiment Station have tendered their services in making the tour available to visitors who may come by train. All members, visiting scientists and agricultural workers interested in plant diseases and their control are extended a cordial invitation to meet with the society. Requests for reservations should be addressed to the committee at A. & M. College, Mississippi.

AWARD OF THE MEDAL OF THE AMERICAN INSTITUTE OF CHEMISTS TO MR. EASTMAN

THE American Institute of Chemists has awarded its medal "for noteworthy and outstanding service to the science of chemistry and the profession of chemist in America" to Mr. George Eastman. Dr. Frederick E. Breithut, president of the institute, has made the following statement:

Mr. Eastman's research work toward simplifying and popularizing photography was begun in 1883 with his first attempts to make the now well-known roll film, and it was a chemical discovery—the use of nitro-cotton dissolved in the proper solvents—which marked the turning point of his career.

One of the first buildings at Kodak Park was a chemical laboratory and throughout the entire development of his work, Mr. Eastman has always availed himself of the services of trained chemists, and of whatever chemical processes could in any way be useful in his projects. A research laboratory, one of the greatest in the country, was established in 1912 to deal specifically with the fundamentals of photography, and to carry on investigations along all lines of interest to the company. Its accomplishments, in chemistry and physics as well as in photography, were so effective that at present the Eastman Kodak Company is practically a self-contained chemical manufacturing concern. It operates plants for the manufacture of its own acids, silver salts, solvents, gelatine, large-scale production of cellulose nitrate and acetate for all kinds of films, and a unique mill for photographic paper.

The most noteworthy service to American chemistry in Mr. Eastman's career was made in 1918 when he approved the establishment by the Research Laboratory of a department of synthetic organic chemistry to manufacture and supply the various synthetic organic chemicals required for research purposes in the United States. The primary object of this much-needed move was to insure the complete independence of the United States in regard to these essential materials, and it received the cooperation and active support of both industrial and academic chemists throughout the country. Continued cooperation with all available sources of supply and an active production program have increased the number of available chemicals to over 2,600—a number of high quality organic chemicals greater than that of any other country. The value of this work was recognized publicly when the Synthetic Organic Chemical Manufacturers Association, in 1925, made Mr. Eastman an honorary member.

Mr. Eastman has always recognized the great value to him of the chemists of the country and of the institutions in which they were trained. His gifts to the Massachusetts Institute of Technology may perhaps be taken as a direct tribute to the chemists and engineers who came from there to assist him in the building up of his great business. In all, over sixty million dollars have been given by him to educational institutions, especially to the

Massachusetts Institute and to the University of Rochester.

The history of the Eastman Kodak Company shows what the application of chemical research can mean in the creation of new wealth in vast amounts. Many of our backward industries could profit by a study of Mr. Eastman's methods. Some of these industries do not yet comprehend what he understood forty years ago. Mr. Eastman learned to apply chemistry to the control of the transformation of the materials which he used, and that knowledge has been applied by him, through the photographic science and art which is now a part of our daily life, to create not only wealth, but service and happiness for all mankind.

SCIENTIFIC NOTES AND NEWS

At the concluding session of the sixty-sixth annual meeting of the National Academy of Sciences on April 30 the following were elected to membership: Dr. C. A. Adams, professor of electrical engineering and dean of the engineering school, Harvard University; Dr. J. W. Alexander, professor of mathematics, Princeton University; Dr. Eugene T. Allen, research chemist, Geophysical Laboratory of the Carnegie Institution of Washington; Dr. Harry Bateman, professor of mathematics, physics and aeronautics, the California Institute of Technology; Dr. Isaiah Bowman, director of the American Geographical Society; Dr. G. P. Clinton, botanist, Connecticut Agricultural Experiment Station, and research associate in plant pathology, Yale University; Dr. William Weber Coblentz, physicist, Bureau of Standards; Dr. Paul S. Epstein, professor of mathematical physics, California Institute of Technology; Dr. Vernon Kellogg, secretary of the National Research Council; Professor Frederick G. Keyes, in charge of the chemical department of the Massachusetts Institute of Technology; Dr. K. S. Lashley, professor of psychology, the University of Chicago; Dr. Berthold Laufer, curator in anthropology, Field Museum, Chicago; Dr. S. C. Lind, director of the School of Chemistry, University of Minnesota; Dr. Frank E. Ross, astronomer at the Yerkes Observatory; Dr. A. H. Sturtevant, professor of genetics, California Institute of Technology. Dr. R. A. Millikan, of the California Institute of Technology, was reelected foreign secretary of the academy for a term of four years. Dr. Karl T. Compton, of Princeton University, was elected a member of the council, to succeed Dr. George E. Hale, and Dr. J. McKeen Cattell, editor of Science, was reelected for a term of three years.

At the dinner of the National Academy of Sciences, held in Washington on April 29, the medals of the academy were presented as follows: The Mary Clark Thompson Medal for the most important services to geology and paleontology to Professor William Berryman Scott, Princeton University; the Agassiz Medal for oceanography to Dr. Johannes Schmidt, director of the physiological department of the Carlsberg Laboratory of the University of Copenhagen; the Daniel Giraud Eliot Medal and Honorarium for the most meritorious work in zoology or paleontology for 1927 to Dr. Erik H. O. Stensiö, of the Royal State Museum of Natural History, Stockholm, and for 1928 to Ernest Thompson Seton, for his book on "Lives of Game Animals." The Public Welfare Medal had been awarded before his death to Stephen T. Mather, organizer and director of the U. S. National Park Service.

At the annual meeting of the American Philosophical Society members were elected as follows: Dr. Norman L. Bowen, petrologist, Geophysical Laboratory, Carnegie Institution; Admiral Richard E. Byrd, Boston, Massachusetts; Cyrus H. K. Curtis, The Curtis Publishing Company, Philadelphia; Dr. Harvey Cushing, Moseley professor of surgery, Harvard Medical School; Mr. Francis Irénée du Pont, E. I. du Pont de Nemours and Company; Raymond Blaine Fosdick, lawyer, trustee of the Rockefeller Foundation and of the General Education Board; Mr. Thomas Sovereign Gates, banker, trustee of the University of Pennsylvania; Mr. William Guggenheim, New York City, manager of the Guggenheim mining and smelting interests in Mexico; Dr. Solomon S. Huebner, professor of insurance and commerce, the University of Pennsylvania; Mr. Archer Milton Huntington, author, New York City; Dr. Merkel Henry Jacobs, professor of general physiology, University of Pennsylvania; Charles Franklin Kettering, president of the General Motors Research Corporation, Dayton, Ohio; Alfred Lee Loomis, banker, director of the Loomis Laboratories for Physics at Tuxedo Park, New York; James Brown Scott, president of the Institution of International Law, Washington, D. C., and trustee and secretary of the Carnegie Endowment for International Peace; Dr. Frederick Tilney, professor of neurology, Columbia University; Dr. Alexander Wetmore, assistant secretary of the Smithsonian Institution. Foreign residents were elected as follows: Professor Albert Einstein, University of Berlin, and Dr. John Stanley Plaskett, director of the Dominion Astrophysical Observatory, Victoria, B. C.

A Franklin Medal of the Franklin Institute has been awarded to Sir William Bragg, Fullerian pro-

fessor of chemistry at the Royal Institution and director of the Faraday Research Laboratory. A dinner in his honor and in honor of other medalists of the institute will be given in Philadelphia on May 21.

Dr. Fay-Cooper Cole, chairman of the department of anthropology at the University of Chicago, has received the gold medal of the Chicago Geographic Society for his anthropological researches. The presentation speech was made by Dr. James Henry Breasted, director of the university's Oriental Institute, who received the same honor in 1929 for research in Egypt and the Near East. Dr. Cole's ethnological investigations have taken him into the Philippines, the Malay Peninsula, Sumatra, Java and Borneo.

The Leslie Dana Medal for the prevention of blindness has been awarded to Dr. George E. de Schweinitz, professor emeritus of ophthalmology at the University of Pennsylvania.

Dr. H. L. Fairchild, emeritus professor of geology at the University of Rochester, celebrated his eightieth birthday on April 29.

At the meeting of the American Association of Pathologists and Bacteriologists held in New York on April 17 and 18 the following officers were elected: *President,* George R. Callender; *Vice-president,* Ward J. MacNeal; *Treasurer,* F. B. Mallory; *Secretary,* Howard T. Karsner; *Incoming member of the council,* O. T. Avery; *Assistant Secretary,* Robert A. Moore. For distinguished service in pathology and bacteriology, the gold-headed cane of the association was presented to Dr. Theobald Smith. The association will meet next year at Western Reserve University on April 2 and 3.

At Harvard University the following promotions have been made to professorships: Leigh Hoadley, zoology; E. A. Hooton, anthropology; Marston Morse, mathematics; H. H. Plaskett, astrophysics; to associate professorships, Kirk Bryan, physiography; H. A. Frost, architecture; J. L. Walsh, mathematics.

Dr. H. J. Wilkinson, formerly senior demonstrator of anatomy at the University of Sydney, has been appointed professor of anatomy at the University of Adelaide, Australia. During the past eighteen months Dr. Wilkinson has been a fellow of the Rockefeller Foundation, working on the innervation of skeletal muscle in the laboratories of Boeke in Utrecht, Agduhr in Upsala and Ranson in Chicago.

Dr. Ward B. White, director of the New York State Bureau of Chemistry, has accepted the position of chief of food control, Food and Drug Administration, U. S. Department of Agriculture, effective on June 2. This appointment is to fill the vacancy caused by the death of Dr. R. W. Balcom.

Dr. Robert Hegner, who has served for the past school year as visiting professor and head of the department of parasitology in the school of Hygiene and Public Health of the University of the Philippines, has returned to the Johns Hopkins University.

Dr. Ernest Carroll Faust, professor of parasitology in the College of Medicine, Tulane University of Louisiana, will spend the months of June, July and August as visiting investigator at the Gorgas Memorial Laboratory. He will take with him two young New Orleans physicians. The group will associate themselves with Dr. Herbert C. Clark, director of the laboratory, Dr. John Miller, pathologist, and Major L. H. Dunn, entomologist, in the study of the significance of amebiasis and of nematode infections in man and monkeys in the Canal Zone.

Dr. David L. Miller, government entomologist of New Zealand, recently spent several days in conference with the entomologists of the U. S. National Museum while on his way to Europe.

It is announced at the Smithsonian Institution that John P. Harrington, of the Bureau of Ethnology, returned to Washington on April 26, after eleven months of field study among the Karuk and San Juan Indians of California, and that Dr. J. W. Gidley, of the U. S. National Museum, left Washington on May 1 to continue work begun in Idaho last summer in the Snake River Valley.

Father Berard Haile, Franciscan monk and for twenty years missionary among the Navajo Indians of Arizona, has joined the scientific staff of the University of Chicago as research associate in anthropology. He will spend the coming summer tenting among the Apaches of New Mexico, equipped with a phonograph for recording their language and music.

The Ottley-Anthony South American Expedition of the American Museum of Natural History has returned to New York after a sojourn of six months in the field. The expedition was undertaken primarily to make a reconnaissance over a very wide area for the purpose of future collecting. In this it was successful, as well as in the collection of a representation of the mammals from the various localities. During the trip the party crossed the Andes no less than six times, and visited six of the South American republics. The expedition was made possible through the generosity of Mr. Gilbert Ottley, who acted as field assistant to Mr. H. E. Anthony, curator of mammals, in charge of the expedition.

THE members of the new administrative board of the American Engineering Council include, in addition to the president, Mr. Carl E. Grunsky, of San Francisco, the following vice-presidents of the council: L. P. Alford and L. B. Stillwell, New York; O. H. Koch, Dallas, Texas; G. S. Williams, Ann Arbor, Michigan. The following representatives of the constituent organizations of the council were also appointed to the board: American Institute of Chemical Engineers—Dr. H. E. Howe, Washington, D. C.; American Institute of Consulting Engineers—Edwin F. Wendt, Washington, D. C.; American Institute of Electrical Engineers—C. O. Bickelhaupt, Atlanta; H. A. Kidder, New York; R. F. Schuchardt, Chicago; Professor C. F. Scott, Yale University; C. E. Skinner, East Pittsburgh, Pennsylvania; American Society of Agricultural Engineers—Professor William Boss, University of Minnesota; American Society of Civil Engineers—H. S. Crocker, Denver; A. J. Dyer, Nashville; Dean Anson Marston, Iowa State College; Frank M. Williams, Albany, New York; American Society of Mechanical Engineers—John Lyle Harrington, Kansas City, Missouri; John H. Lawrence, New York; General R. C. Marshall, Jr., Chicago; Charles Piez, Chicago; E. N. Trump, Syracuse; D. Robert Yarnall, Philadelphia. The following representatives from regional districts were named: George A. Reed, Commissioner of Public Works, Montpelier, Vermont; Burritt A. Parks, Grand Rapids, Mich.; Professor J. S. Dodds, University of Iowa; C. B. Hawley, Washington, D. C.; A. A. Krieger, Louisville, Ky.; W. W. Horner, St. Louis, Mo.

DR. JOHN R. MOHLER, chief of the Bureau of Animal Industry of the Department of Agriculture, has been appointed chief of the delegation which will attend the International Veterinary Congress in London, August 4 to 9. The other American delegates are Dr. George H. Hart, of Davis, Calif.; Dr. Adolph Eichhorn, of the Lederle Antitoxin Laboratories, Pearl River, N. Y.; Dr. Charles H. Stange, dean of Iowa State College; Dr. W. E. Cotton, of Bethesda, Md.; Dr. A. T. Kinsley, of Kansas City, Mo., and Dr. J. F. Devine, of Goshen, N. Y.

LLEWELYN WILLIAMS, assistant in wood technology on the staff of the Field Museum, Chicago, and leader of the Peruvian division of the Marshall Field Botanical Expedition to the Amazon, is expected back in Chicago about the middle of May. He has made collections of woods and other botanical material in the Amazonian forests of Peru, and explored some regions believed never before to have been entered by a white man. Mr. Williams has been in the field about one year. The other division of the expedition, which worked along the Amazon in Brazil under the leadership of Dr. B. E. Dahlgren, acting curator of botany, returned several months ago.

THE eighth meeting of the Harvey Society, which will be the twenty-fifth anniversary meeting of the founding of the society, will be held at the New York Academy of Medicine, on Thursday evening, May 15, at eight o'clock. Dr. Rufus Cole will deliver an address on the progress of medicine during the past twenty-five years, as exemplified by the Harvey lectures, and the "Harvey Film," executed by Sir Thomas Lewis and Dr. H. H. Dale, will be shown.

PROFESSOR WILLIAM J. CROZIER, of the department of general physiology at Harvard University, delivered the Luther Laflin Kellogg Lectures at Rutgers University on April 20, 30 and May 1. The general subject of the lectures was "Aspects of Behavior," with the sub-headings, "Regularities in Living Systems," "Elements of Conduct" and "Mechanism and Behavior."

COLONEL W. A. STARRETT gave the fifth lecture in the Aldred Series at the Massachusetts Institute of Technology on April 25. He spoke on "The Business Aspects of the Modern Builder's Problem." After his lecture Colonel Starrett showed a motion picture of the construction of the Bank of Manhattan Building in New York City.

THE eighteenth annual meeting of the Eugenics Research Association will be held at the Hotel McAlpin, New York, on the morning of Saturday, May 17. The presidential address will be given by Dr. Clarence G. Campbell, of New York, on "Human Evolution and Eugenics." The fourth annual meeting of the American Eugenics Society will be held in the afternoon. A luncheon and a dinner have been arranged.

THE General Education Board of New York has given $500,000 to the Johns Hopkins Hospital and School of Medicine to be used for the completion of the William Osler Medical Clinic and the William Stewart Halstead Surgical Clinic.

WASHINGTON UNIVERSITY (St. Louis) has received a gift of $240,000 from the Rockefeller Foundation. No restriction is placed on the use of the money, except that it be spent principal and interest over a period of seven years in research in pure as distinguished from applied science.

THE Chicago Medical School has purchased from the Francis B. Willard Hospital the property at 710 South Lincoln Street. It will move into its new quarters during June, so that school will open in the new building next September. During the first month

next fall, a homecoming day will be observed, with suitable exercises. This new property will give the school the opportunity for expansion which it has sought for several years. Its dispensary service will be enlarged and it will be able to undertake a series of research problems having to do with the cause, course and prevention of disease.

THE twelfth annual meeting of the American Society of Mammalogists will be held at the American Museum of Natural History, New York City, from May 21 to 24. The first three days will be devoted to the presentation of papers, included among which will be those comprising a symposium on the gorilla, arranged by Dr. William K. Gregory, and another on the utilization of zoological park collections for research, arranged by Dr. W. Reid Blair.

DURING the recent meeting of the Ohio Academy of Science, the committees appointed on March 8, at the joint meeting of the Akron Society of Applied Physics and the Central Ohio Physics Club, reported in favor of the formation of the "Ohio Physics Association," consisting of all local clubs and societies that are devoted to physics; and a news publication entitled *Physics News,* whose purpose will be to give personal, industrial and academic news to physicists. One of the purposes of the Physics Association is to edit this *Physics News* and to encourage and provide for joint meetings of various clubs; and to encourage formation of local physics clubs. It is felt that industrial and academic physics may be brought into a closer and better cooperation by such an association, and that high-school physics teachers may receive also some benefits thereof. The affairs of the Physics Association are to be carried on by an executive committee, composed of the last past president of the various clubs.

DISCUSSION

RENEWAL OF THE AMERICAN MUSEUM EXPLORATIONS IN THE GOBI DESERT

IN response to the article which appeared in SCIENCE, September 27, 1929, entitled "Interruption of Central Asiatic Exploration by the American Museum of Natural History," and also in response to letters addressed at the same time to the directors of leading institutions in Peiping (Peking), I have received as President of the American Museum of Natural History very courteous letters from three of the leading directors of Peiping institutions as follows:

The National Library of Peiping, Acting Director T. L. Yuan.

The Geological Survey of China, Director W. H. Wong.

The Committee for the Preservation of Ancient Objects, Chairman Tchang Ki; and the Chairman of the Peiping Branch, Dr. Ma Heng.

To these most welcome letters President Osborn sent the following reply in identical language to each of these institutions:

February the first,
Nineteen hundred thirty

DEAR SIR:

I acknowledge with pleasure the receipt of your letter of December 12th in reply to my letter of October 22nd and the copies of SCIENCE containing my official report. I am very glad to learn from the concluding paragraph of your letter of your friendship for the American Museum, of your interest in the scientific importance of our Central Asiatic Expeditions and your desire to do all within your power to enable the Expedition to resume its work next year.

The interruption of the Expedition has been a very great blow to the advancement of the sciences of geology and paleontology. It has entailed very serious financial loss to the American Museum of Natural History; it has been a severe disappointment to the two hundred and fifty-three subscribers to the Central Asiatic Expeditions in thirty-seven states of the Union. It has been a great disappointment to me personally for during my visit to Peking in 1923 I planned with Director V. K. Ting of the Geological Survey and Director Kung Pa King of the Art Museum and others to help build up a natural history museum in one of the palaces, to supply it with specimens of all kinds from our collections here but especially with duplicates from the Asiatic Expeditions.

The representatives of this Museum, Dr. Roy Chapman Andrews and Mr. Walter Granger, are men of the finest personal character, reputation and deportment who have been with me for thirty-nine years and twenty-one years respectively. All the representatives of all the American Museum Expeditions to all parts of the world bear official instructions to exercise great courtesy, integrity and fidelity to the customs and laws of the countries they visit.

Especially as regards human Archæology and original and historic monuments relating to the civilized history of man, the American Museum has strongly supported the laws of different countries both in the Old and New Worlds. We believe they should be kept in the countries where they are found provided that these countries have the means and the intention of preserving and caring for them as you are now doing in your honorable Society for the Preservation of Ancient Objects.

The American Museum and its representatives in every country have taken an entirely different ground towards geologic, palæontologic, and zoologic specimens. We have collected fossils in every country and we have welcomed students and explorers from every other country within our states and territories. From time immemorial scientific parties from other countries—from France, Germany, England and other European states—have been

freely collecting fossils in America or freely purchasing them by export through dealers.

These fossils from India and China are generally found in a most fractured and imperfect condition and only through comparison in our Museum with other fossil and living specimens and through access to the vast literature of palaeontology and geology is it possible to determine what they are. I personally have labored for months with the greatest difficulty on the fossils received from the Central Asiatic Expedition and it is only my fifty years of study which have enabled me to correctly interpret those found in the first year before the completion of the United States Geological Survey Monograph which I am now sending to the National Geological Survey of China.

It is very rare that fossils have an intrinsic financial value. Their value comes only from the study which is put upon them. In this respect they differ entirely from archaeological specimens which often have immediate and great intrinsic value.

I hope in this spirit of a new understanding that the National Geological Survey of China will cordially support the renewal of the Central Asiatic Expedition and will trust to our fairness in having due regard to the advance of science in China and our integrity in carrying out our agreements along the lines which prevail in all the countries with which we are in cooperation for the advancement of geology and palaeontology.

Sincerely yours,

HENRY FAIRFIELD OSBORN,
President

DR. W. H. WONG, DIRECTOR
THE NATIONAL GEOLOGICAL SURVEY OF CHINA

On March 18, President Osborn received a cable from Dr. Andrews reporting on the result of his negotiations with Professor Ma Heng, Chairman of the Commission for the Preservation of Ancient Objects, requesting that the following announcement be made in SCIENCE:

President Osborn is glad to announce that the difficulties regarding the work of the Central Asiatic Expedition have been satisfactorily adjusted. An understanding has been reached between both the Cultural Society and the Commission for the Preservation of Ancient Objects officially appointed by the Government of Nanking, with the American Museum of Natural History. Members of both the Cultural Society and the Commission for the Preservation of Ancient Objects are in sympathy with scientific men in other parts of the world and appreciate the importance for China and the world of science of mutual harmony, while maintaining for China a primary interest in its scientific treasures. The Central Asiatic Expedition and the Commission for the Preservation of Ancient Objects will cooperate in the coming expedition in results as well as in the scientific study of collections.

This message makes it clear that Dr. Andrews is now making ready to resume the work in Mongolia this season. Curator Walter Granger, chief palæontologist of the expedition, now in the American Museum working up the 1928 collections, accompanied by Mr. Albert Thomson, assistant in palæontology, and Mr. J. McKenzie Young, head of the motor transport, are preparing to sail for China as early as they receive positive word from Chief Andrews.

On March 24 Andrews cabled that the agreement with the Cultural Society and the Commission for the Preservation of Ancient Objects had been signed by both parties, and Messrs. Granger, Thomson and Young are to take the quickest route to Peiping. This means that the expedition will be equipped and ready to start north into the Gobi Desert about May 1. This harmonious outcome of negotiations which have been in progress since August, 1928, will be extremely gratifying to geologists and paleontologists all over the world and will renew the cooperative relations between the American Museum and the scientific institutions of China.

Postscript, April 29: Dr. Roy Chapman Andrews cables that the Chinese Government of Nanking approves the recommendation of the Cultural Society of Peiping for the renewal for the fifth season of exploration in the Desert of Gobi succeeding the active seasons of 1922, 1923, 1925, 1928. Messrs. Granger and Thomson are due to arrive in Peiping on May 9 and Dr. Andrews cables that all the arrangements have been made to reenter Mongolia immediately.

The American Museum of Natural History desires to express to the Cultural Society, the Commission for the Preservation of Ancient Objects and to the Government of Nanking its appreciation of their liberal action in this matter and its desire to cooperate in the advancement of paleontology and geology in China as well as throughout the world.

HENRY FAIRFIELD OSBORN,
President

AMERICAN MUSEUM OF NATURAL HISTORY,
MARCH 24, 1930

AUSTRALOPITHECUS NOT A CHIMPANZEE

Australopithecus, the fossil juvenile anthropoid ape from Taungs, South Africa, has been a center of controversy ever since the preliminary description of the skull by Professor Dart in 1925. Opinions as to its position have ranged from the belief that it is close to the line of human evolution to the view that it is merely a young chimpanzee. Unfortunately, few who have discussed it have seen the original, and have based their opinions on photographs or somewhat inadequate casts.

During a recent visit to Johannesburg I had the pleasure, through the kindness of Professor Dart, of studying the specimen under the guidance of Dr.

Broom. I do not intend here to enter into a general discussion of the position of this interesting fossil, but wish merely to protest emphatically against its dismissal as "merely a chimpanzee." Certainly, of living anthropoid apes, the chimpanzee is the only one with which a comparison might possibly be made. Both Professor Dart and Dr. Broom, however, have pointed out many features in which this specimen differs from this living form. Direct comparison of the fossil with chimpanzee skulls of a similar degree of development renders it obvious that *Australopithecus* is specifically distinct, and generic distinction seems almost equally certain.

New light is now shed on the subject through the fact that Professor Dart has skilfully disarticulated the jaw, revealing the dentition in its entirety. A study of the teeth suffices to render the assignment of *Australopithecus* to the chimpanzees absolutely out of the question. The vertical position of the incisors as contrasted with the forward slope of those of the chimpanzee has been discussed by Dart and Broom. The canines are small as compared with the milk molars; these teeth are much larger than those of the chimpanzee and in their size, shape and structure appear to be outside the possible range of variation of that genus and, in fact, resemble more closely the human type.

Attempts to settle the phylogenetic position of *Australopithecus* might best be postponed until the publication of Professor Dart's monograph on the skull. But in the meantime it can not be too strongly emphasized that *Australopithecus* is not a chimpanzee, but a new and separate type of anthropoid ape, worthy of careful consideration in any discussion of higher primate phylogeny.

ALFRED S. ROMER

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UNIVERSITY OF CHICAGO

STRIATED COBBLES FROM TEAY VALLEY, WEST VIRGINIA

THE occurrence of striated cobbles and boulders in regions south of the glaciated area has been discussed recently by Wentworth.[1] In examining gravels in Teay Valley, West Virginia, during the past summer the writer found striated cobbles in a new locality, and since their presence here sheds additional light on the origin of such cobbles and also on the problem of the diversion of the Kanawha River from its old course through Teay Valley, it is desired to put the facts on record.

Teay Valley has long been recognized as an abandoned river valley, having been first brought to attention by I. C. White in 1884 and described in some detail a few years later by G. F. Wright. In 1903 W. G. Tight discussed it in detail, showing its relation to other preglacial drainage lines. It is now generally accepted to be the abandoned channel of the Kanawha River, which deserted this northwesterly course for its present northward course.

Teay Valley is about a mile wide and thirty-five miles long, extending from St. Albans to Huntington. The Teay formation, which consists of gravel grading upward into finely laminated clay, was deposited in this valley. The striated quartzitic cobbles, ranging in diameter from two to ten inches, were found in exposures of the gravel in cuts made by the Chesapeake and Ohio Railroad about three miles east of Milton.

Three possible origins for striated cobbles south of the margin of continental glaciation have been suggested.[2] The lithology, location and association of the cobbles in the Teay formation make the hypothesis of intense valley ice action the most plausible explanation for their striation.

In order to explain the character and distribution of the clays of the Teay formation, Campbell[3] has suggested that local ice dams existed for some time, causing the ponding necessary for the Teay River to seek the new course now occupied by the Kanawha, and also deposition of the laminated clays. Striated cobbles here lend support to the ice dam hypothesis in that it indicates ice action in Teay Valley at the time the Teay formation was deposited.

A more detailed description, with illustrations of the cobbles, will be published elsewhere.

JULIAN J. PETTY

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THE NATIVITY OF THE PUMPKINS

VARIOUS opinions have been expressed as to the nativity of *C. pepo* and *C. moschata,* our cultivated pumpkins. Some botanists regard them as of American origin and others as native to eastern Asia.

Since the plant has never been found in its natural habitat the subject has been one of speculation based upon certain terms of inexact meaning. Recently, however, there has come to light through the activities of the archeologists a rich store of material which throws important light on this subject. In the recoveries from the Cliff Dweller ruins fragments of the rind and peduncle in an excellent state of preservation have been secured and in the mortuary bowls seeds of cucurbits are found, the taxonomic characters of which are clearly defined. This material is

[1] C. K. Wentworth, "Striated Cobbles in Southern States," *Bull. Geol. Soc. Am.*, 39: 941–954, 1928.

[2] *Op. cit.*, p. 948.

[3] M. R. Campbell, SCIENCE, n.s., 12: 98–99, 1901.

now in the Peabody Museum of Harvard University and was collected by Messrs. Kidder and Guernsey. Also, in the Colorado State Historical Museum, are found specimens recovered by Dr. Paul S. Martin. The writer has been privileged to study these collections and finds numerous specimens of *C. moschata* and *C. pepo*. In the instance of the Peabody collection, some of the specimens are quite ancient. According to Kidder they are from the Basket Makers, a culture antedating the Cliff Dwellers, and are regarded by him as belonging to the period 1500 to 2000 B. C.

Interesting material of a similar character has come to light in the explorations made by Mr. Neil M. Judd under the direction of the National Geographic Society at Pueblo Bonito, New Mexico. In this material fragments of stems and seeds are found which are identified by Dr. C. V. Coville as *C. pepo* and *C. moschata*.

From the Everglades of Florida Dr. John K. Small has collected a plant of unknown origin which is running wild and is known as the Seminole Indian pumpkin, a variety of *C. moschata*.

In the Guadalupe Valley of southern Texas occurs a cucurbit closely related to *C. pepo* which appears to be indigenous. L. H. Bailey collected specimens in its natural habitat which he identifies as *C. texana*.

The fact that *C. pepo* and *C. moschata* are indigenous to North America seems clearly established. The nativity of the third species, *C. maxima*, the squashes, is still in the dark, and we are in hopes that the archeologists may in time be able to throw light upon this subject also.

A. T. ERWIN

IOWA STATE COLLEGE

STARLINGS IN OKLAHOMA

THAT the starling this winter invaded the state of Oklahoma may be of interest to some ornithologists and zoologists. The starlings have not been reported before this year for this state, but appeared in considerable numbers in Tulsa County in December, 1929, as reported by Miss Edith Force, of the Tulsa city schools. The birds appeared on the campus of the University of Tulsa at different times during the three weeks of cold weather beginning January 10. During this period, there was a snowfall of about twenty inches, and the thermometer reached the zero mark at different times. On the night of January 13, amidst a storm of snow and sleet, a starling flew through an open window of one of the dormitories where it was caught and identified the next morning. Dr. R. D. Bird, of the department of zoology, Oklahoma University, says that starlings appeared on the state university grounds and in the vicinity of Norman, Oklahoma, at the same time they were seen at Tulsa in January. The starlings left the above-mentioned communities when the cold weather broke up, during the first week in February, and so far as the writer knows, no one has observed them in this locality since.

H. D. CHASE

UNIVERSITY OF TULSA

SCIENTIFIC BOOKS

Operational Circuit Analysis. By VANNEVAR BUSH, Eng.D., professor of electric power transmission, Massachusetts Institute of Technology. With an appendix by Norbert Wiener, Ph.D., assistant professor of mathematics, Massachusetts Institute of Technology. John Wiley and Sons, Inc., New York; Chapman and Hall, Ltd., London, 1929.

IT is now nearly fifty years since Heaviside introduced the shorthand operational methods associated with his name for the solution of circuit problems arising in telegraph and telephone engineering. The adoption of these methods by engineers has been relatively slow. This has been due partly to a lack of a compact, orderly exposition of the methods and partly to a natural aversion to the intellectual labor of mastering a novel discipline which appeared to offer a less rigorous alternative to classical methods which had to be mastered in any case as a preliminary to the understanding of the new tools. Those who were only occasionally faced with such problems could scarcely be expected to make an attempt at such a mastery.

The great expansion of the field of communication engineering in the last twenty-five years and the applicability of its results to other fields (notably acoustics) have, however, forced an intensive development of the mathematical tools available, in which increasing attention has been paid to the Heaviside methods so that a considerable literature now exists. The present work is, however, the first attempt to embody the subject in text-book form.

Professor Bush is to be congratulated on the success with which he has performed his task. The superposition theorem, the integral theorem and the expansion theorem are developed in a manner to bring out clearly their interrelations and their relative contribution to the direct operational procedure. The fundamental grounding of the Heaviside methods in the Fourier analysis and their relation to the

theory of functions of a complex variable are adequately treated. The style in which the book is written is simple, direct and not lacking in a wit entirely appropriate to a disciple of his master, though free from the bitterness and even malice that so often characterizes the latter's amusing outbursts.

A considerable number of interesting and suggestive problems conclude each chapter, and a valuable table of operational formulas is given as an appendix. Professor Bush's colleague, Professor Wiener, has contributed a brief but valuable appendix on Fourier analysis and asymptotic series. The bibliographical references are ample, and the text seems to be reasonably free from typographical errors.

It is to be hoped that in future editions the important subject-matter of Chapter XV, "Networks with Variable Parameters," may be treated at greater length. The problems arising under this heading are at the same time of the greatest importance and offer the most formidable difficulties. In particular, it would seem desirable to add some account of the "perturbation" methods of approximate solution, which Van der Pol has shown how to adapt from astronomical to vacuum tube circuit problems.

LYNDE P. WHEELER
NAVAL RESEARCH LABORATORY

The Economics of Forestry. By W. E. HILEY, M.A., Oxford. Clarendon Press, 1930. Price 21/–.

NEW ground has been broken by the publication on March 20 of a book on "The Economics of Forestry," by Mr. W. E. Hiley, M.A., of the School of Forestry, Oxford. Mr. Hiley is well known in forestry circles not only in Great Britain but also in America and throughout the British Empire by reason of his publications on forestry subjects, one of the most important of which is his book on "The Fungal Diseases of the Common Larch." After the publication of this work he decided to give up the mycological side of forestry, being attracted by the possibilities of the practically unknown field of forest economics, and he started a course of lectures on this subject in the Oxford Forestry School. From this has developed the matter which has been so carefully and lucidly elaborated in the pages of this book, in which the theory of forest economics is applied to the practice of forestry in a more definite manner than has hitherto been done.

Whether the object of forestry should be to obtain the best financial returns has often been questioned; other objects, such as the fixation of mountain slopes and sand dunes, the regularization of the water flow and protection from wind, must always be kept in mind by the forest officer. But apart from these aspects of the subject, the prospect of obtaining satisfactory profits is a very important incentive to private afforestation; in state forestry, also, it is desirable that for every dollar spent the greatest possible value of timber should be produced in the shortest possible time. Thus, in fact, forest economics must be the determining factor in state, as well as private, forestry.

Owing to the long period of production in forestry, calculations have to be made with compound interest, and various methods have been used for estimating profitableness. Mr. Hiley particularly favors two methods: that of determining the "financial yield," which is the rate of compound interest earned on a plantation or forest on the money invested in it; and the method of "cost of production per cubic foot" calculated by allowing some fixed rate of interest on capital. With either method the costs of all operations and the value of intermediate returns are taken into account.

He has applied these methods to all British-grown species for which data are available, and has shown that, whereas Scots pine (*Pinus sylvestris*), for instance, is very expensive to grow and can yield only a low rate of interest on capital, Douglas fir (*Pseudotsuga taxifolia*) and Sitka spruce (*Picea sitchensis*) are very cheap to grow and may yield a comparatively high rate of interest. Since Scots pine is a very easy tree to cultivate and grows on cheap land, such a result is not at first obvious; the high cost of production is due to the slow rate of growth and the long rotation.

It is also shown that timber can be grown much more cheaply on good land than bad even when high prices have to be paid for good land. Heavy thinning is generally more profitable than light thinning, and wide planting than close planting. Also small sizes of timber are so much cheaper to grow than large sizes that, as virgin timber becomes scarcer, there will be very strong inducements towards the use of laminated wood and other artificial forms of large timber.

Thus far the book follows the course which we should expect the study of forest economics to follow in Britain, where reafforestation is the order of the day and a large amount of capital is being invested in making future forests. But in America, too, now that more and more attention is being paid to the reafforestation of denuded lands, it is becoming imperative that the relative economic attractiveness of various tree species and methods of management should be studied in detail. For the particular conditions covered by Hanzlik's data the author has calculated the most favorable rotation for growing Oregon pine ("Douglas fir") in the western states.

Where forests have not yet been destroyed the author shows it is possible to put them under a form of management by which they will yield a continuous supply of timber. Where the existing stand is sufficiently valuable this form of development may be secured without investing fresh capital. It does, however, require restraint in the exploitation of the existing forests, and the economics of this type of development is rather different from that of afforestation. In the last chapter, which is entitled "The Economics of Sustained Yield," the comparative economics of devastation and conservative forest management is discussed, with special reference to America, and tendencies are traced towards a more constructive view of company management being adopted.

The profitableness of forestry will be greatly affected by any change in prices. Questions of timber resources and consumption are dealt with, both as regards Europe and America, and price movements are traced for nearly ninety years. These prices have been corrected for changes in the purchasing power of money, so that movements in real prices may be observed. It is interesting to note that, although the real price of sawn softwoods imported in Britain rose rapidly from 1871 to 1900, there was a subsequent fall lasting till the great war and present real prices are little, if any, higher than in 1900.

J. BURTT DAVY

IMPERIAL FORESTRY INSTITUTE,
OXFORD UNIVERSITY,
MARCH 25, 1930

SCIENTIFIC APPARATUS AND LABORATORY METHODS

FRUIT AND VEGETABLE PIGMENTS AS INDICATORS

A FEW years ago a study was made of the coloring matter of certain European grapes by Willstätter and Zollinger,[1] and of several American varieties by Anderson and Nabenhauer.[2, 3] All the pigments were found to be chemically similar, being composed of the monoglucoside oenin in the case of the European grapes, and in the case of the American of anthocyanin, which is similar to oenin but with a smaller percentage of methoxyl. It was noted that solutions of some derivatives of anthocyanin turned bright red when acidified and blue or bluish-green when made alkaline, the pigment decomposing in a short time if left in alkaline solution. It does not appear that these workers investigated the indicator values of grape pigments, and Clark does not list any of the products of grapes or of grape skins among the indicators he describes in his book on hydrogen ions.[4] Industrially, however, advantage is taken of the color changes of grape pigments by wine manufacturers, "since red wine is very commonly titrated for total acidity, using the color change from red to green as an endpoint."[5]

After noting the color change in grape-juice while working on a problem in dietetics and recalling that Clark's list of indicators includes the extract of red cabbage,[4] it occurred to us that the pigments of other fruits and vegetables might exhibit similar characteristics. We accordingly began to study such varieties as were readily obtainable, testing for the presence of pigments showing a color change, for the pH range of such color changes as were observed and for the practical value of the pigments for use where liquid indicators or test papers might be needed.

Apricots, carrots, peaches, pears, persimmons and tomatoes failed to yield pigments with indicator characteristics. The pigment of red beets remained red throughout the acid range and into the alkaline range at least as far as pH 13.0. On the other hand, red apples, blackberries, blueberries, prickly pear cactus fruit, black cherries, cranberries, dewberries, grapes of all colors from red to black, loganberries, Satsuma plums, pomegranates, black and red raspberries and strawberries proved to contain pigments of more or less indicator value.

In all cases we at first made decoctions of the fruits or vegetables. Of grapes and apples we used only the skins. The test material was simmered for about fifteen minutes in as little water as practicable, then the colored solution was separated from the pulp by straining through several layers of cheesecloth. We found later that with blackberries, cactus fruit, black cherries, dewberries, pomegranates, raspberries and strawberries a better solution could be obtained by crushing the raw fruit and pressing out the juice. To clear and preserve the solutions we added half their volume of 95 per cent. alcohol, let them stand for several hours and then filtered them.

A series of standard buffers was used in testing the pH range covered by the color changes. The following table shows what we found in the case of ten pigments.

The pigments from all colors of grapes were found to be similar as to indicator characteristics, the only

[1] R. Willstätter and E. H. Zollinger, *Ann. Chem.*, 408: 83, 1915; 412: 195, 1916.

[2] R. J. Anderson, *J. Biol. Chem.*, 57: 795, 1923; 61: 685, 1924.

[3] R. J. Anderson and F. P. Nabenhauer, *J. Biol. Chem.*, 61: 97, 1924.

[4] W. M. Clark, "Determination of Hydrogen Ions," pp. 84–98, 1923.

[5] S. R. Benedict, personal communication.

difference being that the darker the color of the grapes the more concentrated the solution of pigment obtainable from their skins. The same is true of the

Fruit source	Color change	pH range
Apples	Red to yellowish-green	6.2– 7.2
Blackberries	Red to dark grayish-blue	6.0– 7.4
Blueberries	Reddish-purple to greenish-purple	6.2– 7.2
Cactus	Red to faint purple	9.0–12.0
Cactus	Faint purple to reddish-brown	12.0–13.0
Cherries	Red to bluish-purple	6.0– 7.2
Cranberries	Red to yellowish-green	6.2– 7.2
Grapes	Red to purple	5.0– 6.6
Grapes	Purple to green	6.6– 7.6
Plums	Red to yellowish-green	6.2– 7.2
Pomegranates	Red to purple	6.0– 6.8
Pomegranates	Purple to green	6.8– 7.6
Strawberries	Red to yellowish-green	6.2– 7.2

class of fruits consisting of blackberries, dewberries, loganberries and raspberries. We have not had time to purify these fruit pigments and study their chemical composition, but from the colors they show and the pH range they cover we judge that most of them are derivatives of anthocyanin or similar compounds.

Any of the pigment solutions, except that of cactus fruit, can be used in the titration of acids. As kept in the form of alcohol preserved solutions, they have stood for several months without showing any signs of deterioration. They can not be used in titrating bases, for in a solution which is no more than moderately alkaline they soon decompose, all of them producing a brown color which does not change when acid is added. The faint purple and reddish-brown colors of the cactus pigment are comparatively resistant to alkalis, but the pH range of the color change is too far over on the alkaline side to make the pigment of much use in titration work. Since, however, it is not poisonous, has but little odor or taste and holds its deep red shade over so wide a pH range, one can easily see why certain housewives in parts of the United States where prickly pear cactus grows have found it so satisfactory a coloring agent in jelly-making.

The most practical use that we have found for these indicators is in making test papers. Soaking a cheap grade of thin filter-paper in the crude decoctions—it is not necessary to clear with alcohol for this purpose—and then drying the paper, gives a satisfactory neutral-tinted product in most cases. The natural acid of apples, cranberries, plums and pomegranates is sufficient to cause the production of red papers. When such papers are dry it is best to wet them with .2 per cent. ammonium hydroxide, rinse quickly and dry again. This treatment changes the color to a neutral tint. The fact that these fruit pigment test papers have a definite neutral tint, as well as an acid tint and an alkaline tint, is an advantage. Their color changes, however, are in some cases a bit different from those of the corresponding pigment solutions. For this reason we add a brief table to show what may be expected of the papers.

Fruit source	Neutral tint	Acid tint	Alkaline tint
Apples	Grayish-purple	Red	Green
Blackberries	Purple	Red	Bluish-green
Blueberries	Purple	Red	Blue
Cherries	Reddish-purple	Red	Bluish-green
Cranberries	Faint purple	Red	Light green
Grapes	Purple	Red	Bluish-green
Plums	Faint purple	Red	Light green
Pomegranates	Purple	Red	Bluish-green
Strawberries	Reddish-purple	Red	Light green

SUMMARY

(1) Solutions of many fruit pigments act as indicators.

(2) These solutions are easily prepared and stable, and the pH range of their color changes is in most cases conveniently near the neutral point.

(3) As liquid indicators they can be used in titrating acids, but not bases.

(4) Their greatest usefulness depends upon the fact that very satisfactory test papers can be made with them in a simple and inexpensive way.

O. B. PRATT
H. O. SWARTOUT

RESEARCH LABORATORIES OF THE
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THE SPOTTING METHOD OF WEED ERADICATION

IN the eradication of ragwort, reported by Grimmett,[1] mention is made of placing about an ounce of dry mixture of equal parts of finely crystallized sulphate of iron and sodium chloride on the crown of the individual plants. A later examination of the area so treated showed 100 per cent. killing. The plants were rotted and could be pulled out easily. In no case did regrowth occur from the roots. In most cases a ring of grass from a few inches to a foot in diameter was also killed.

Some years ago the writer, while considering methods of eradicating plantain and dandelion in a young blue grass lawn, conceived the idea of using a fer-

[1] B. E. R. Grimmett, "Chemical Eradication of Ragwort," *N. Z. Jour. of Agr.*, 34, 4: 256.

tilizer instead of a toxic salt to plasmolyze the weeds. By so doing the surrounding grass would be stimulated after the weed was killed and after the fertilizer had been washed away sufficiently from the point of application to reduce it to a concentration that is non-plasmolytic.

Each spring, for several years, this spotting procedure has been practiced. As much sulphate of ammonia as can be held between the fingers and thumb is placed on the crown of the weeds. As Grimmett reported, weeds so treated die quickly and completely. The grass surrounding the weed dies also, but in no case is the circle of dead grass so large as one foot across, as Grimmett reported sometimes occurs from the use of the toxic salt. Shortly the growth of the grass bordering the circle is tremendously accelerated so that within a few weeks the whole bare spot is covered with a thrifty growth of grass.

E. P. DEATRICK

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SPECIAL ARTICLES

CAPACITY OF CONDENSERS IN SERIES

THE object of the present note is to show that the conventional formulation for the total capacity of electrical condensers joined in series or cascade is unnecessarily inexact. The formulation referred to is: The reciprocal of the total capacity of any number of condensers connected in series equals the sum of the reciprocals of the discrete capacities of all the individual condensers. The cause of the inexactness of the formulation lies in the fallacious idea which is brought out typically in the following quotation from a generally excellent book: "Since the outflow from one condenser constitutes the charge on the next, the charge Q on the positive coating of each must be the same and equal to that communicated to the first condenser." This premise was found by me to be involved, either explicitly or implicitly, in all the relevant books, save one, which were accessible in two libraries. By no means are all these books elementary texts; on the contrary, the names of several of the most noted living Dutch, English and Russian physicists are to be found on the respective title-pages. The exceptional book is by E. Mascart and J. Joubert (tr. by E. Atkinson), entitled "A Treatise on Electricity and Magnetism." A qualitative hint at the correct state of electrical distribution is given on page 72 of the first of the two volumes.

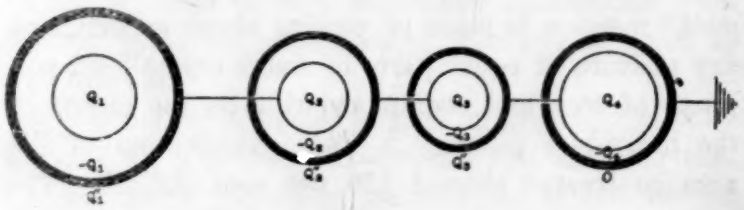

FIG. 1

It will be sufficiently general for the purposes of this note to outline the proof of the rigorous formula for the case of four spherical condensers connected by ideal wires of infinite length and zero capacity, as suggested by the accompanying diagram. The radii of the central sphere, of the inner surface of the concentric shell and of the outer surface of the shell will be denoted respectively by r_i, r_i' and r_i'', for the i^{th} condenser ($i=1, 2, 3, 4$). The corresponding charges on these three surfaces are Q_i, Q_i' and Q_i''. $1/C_i = \kappa(1/r_i - 1/r_i')$ and $C_i'' = r_i''$. The charge Q_1 is at the potential V_1 and the outside of the fourth condenser is "earthed." Then the following conditions must be fulfilled:

$$\begin{aligned} V_1 = Q_1/C = Q_1/C_1 + Q_1''/C_1'' \\ -Q_1 + Q_1'' + Q_2 = 0 \\ -Q_2 + Q_2'' + Q_3 = 0 \\ -Q_3 + Q_3'' + Q_4 = 0 \\ Q_1''/C_1'' = Q_2/C_2 + Q_2''/C_2'' \\ Q_2''/C_2'' = Q_3/C_3 + Q_3''/C_3'' \\ Q_3''/C_3'' = Q_4/C_4 \end{aligned}$$

Elimination of all the Q's from the preceding equations leads to the following general type of continued fraction:

$$\frac{1}{C} = \frac{1}{C_1} + \cfrac{1}{C_1'' + \cfrac{1}{\cfrac{1}{C_2} + \cfrac{1}{C_2'' + \cfrac{1}{\cfrac{1}{C_3} + \cfrac{1}{C_3'' + C_4}}}}} \qquad (1)$$

The way in which the various capacities are involved in formula (1) is instructive and interesting. Formula (1) can not reduce rigorously to the conventional equation

$$1/C = 1/C_1 + 1/C_2 + 1/C_3 + 1/C_4 \qquad (2)$$

unless $C_1'' = 0$, and this is impossible since the outside radii of spherical condensers can not vanish. Incidentally

$$Q_4 = Q_1 - (Q_1'' + Q_2'' + Q_3'')$$

so that Q_4 can not equal Q_1, since the parenthetical trinomial is always finite.

Although the goal of this note has been reached already in the above theoretical deductions, it seems desirable to give some numerical data in order to show the order of magnitude of the charges and errors.

Let all the condensers be identical with $r_1 = 10.00$

cm, $r_1' = 10.20$ cm, $r_1'' = 10.25$ cm and hence $C_1'' = 10.25$ e.s.u. and $C_1 = 510$ e.s.u.

Case 1. $\kappa = 1$. Then $100Q_4/Q_1 = 89.08\%$, $100\ Q_3''/Q_1 = 1.79\%$, $100\ Q_3/Q_1 = 90.87\%$, $100\ Q_2''/Q_1 = 3.62\%$, $100\ Q_2/Q_1 = 94.48\%$, $100\ Q_1''/Q_1 = 5.52\%$. Formulas (1) and (2) give $C = 136.207$ and $C = 127.5$ respectively, hence the error of equation (2) is about -6.4% in this special case.

Case 2. $\kappa = 80/17 = 4.706$ (paraffin oil). $C_1 = 2400$ e.s.u. $100\ Q_4/Q_1 = 97.49\%$, $100\ Q_3''/Q_1 = 0.42\%$, $100\ Q_3/Q_1 = 97.91\%$, $100\ Q_2''/Q_1 = 0.83\%$, $100\ Q_2/Q_1 = 98.74\%$, $100\ Q_1''/Q_1 = 1.26\%$. Formulas (1) and (2) give $C = 608.915$ and $C = 600$ respectively, hence the error of equation (2) is now about -1.5%.

In conclusion, attention may be called to the fact that it can be shown, by paying special attention to the definitions involved, that the general ideas presented above can be extended to the case of parallel-plate condensers.

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FURTHER OBSERVATIONS ON ADRENALECTOMIZED CATS TREATED WITH AN AQUEOUS EXTRACT OF THE SUPRARENAL CORTEX

IN a brief communication which appeared in this journal a few weeks ago (SCIENCE, 71: 321–322, 1930) the writers described the preparation of an active extract of the suprarenal cortex which maintains bilaterally adrenalectomized cats in normal condition. At the time of publication our oldest experimental animals had been under observation eighty days. Several of our treated cats recently reached their one-hundredth day of survival and were in excellent condition at that time. They all showed steady weight increases and could not be distinguished by their behavior from unoperated control animals.

At present we have no idea how long cats so treated will survive, since none of the animals receiving extract has presented symptoms, and so far as we know to the contrary they would survive indefinitely. However, when the animals reach the hundredth day of survival administration of extract is discontinued, and in every case tested death from adrenal insufficiency results within ten days. The onset of symptoms is abrupt, more so than in adrenalectomized cats not receiving treatment. Autopsy reveals the same findings as observed in untreated animals dying of adrenal insufficiency. The fact that the long surviving cats invariably die with typical adrenal insufficiency symptoms following cessation of treatment demonstrates conclusively that it is the extract which keeps them alive and in good health, and that no question of accessory cortical tissue is involved. We have used chiefly male cats in our survival experiments.

The following table shows the weight changes in a typical experimental cat. The striking weight loss which follows withdrawal of treatment is characteristic of all our animals.

TABLE I

No. 1 MALE				
Dec.	16	3160	grams.	R. adrenal removed.
Dec.	24	3185	"	L. adrenal removed. Treatment started Dec. 25.
Jan.	28	3320	"	
Feb.	12	3300	"	
March	5	3420	"	
March	12	3500	"	
March	22	3765	"	
March	30	3820	"	
April	3	3835	"	Extract discontinued. Animal in perfect health.
April	7	3630	"	
April	8	3610	"	Symptoms of suprarenal insufficiency.
April	9	3515	"	Symptoms of suprarenal insufficiency.
April	10	3400	"	Marked symptoms.
April	11	3355	"	Prostration, death.

Recently we have completed a series of experiments in which the adrenalectomized animals were not treated until adrenal insufficiency symptoms had developed, such as total anorexia, weight losses of several hundred grams and weakness in limbs so that the animal swayed unsteadily when walking. By injecting subcutaneously 2 cc of cortical extract three times daily, we have been able to bring such cats back to normal health, with complete disappearance of all symptoms of adrenal insufficiency. Following return to normal the animals are then given the regular treatment of 0.5–1 cc of extract per kilogram of body weight daily. This is an arbitrary dose since the minimum dosage has not been determined. We have several such animals in the laboratory which have returned to normal and are now in their fiftieth day of survival.

It is interesting to note that the disappearance of adrenal insufficiency symptoms is a fairly slow process and requires from four to five days of treatment. The maximum quantity of fluid given in twenty-four hours to any one cat showing symptoms is six cubic centimeters. This amount can be cut in half by further concentration of the extract and the results are the same.

It has been found that the fractions containing the cortical hormone can be conveniently and safely

stored in benzene or alcoholic solution. The writers prefer to use the term *cortical hormone* pending definite knowledge of the chemical nature and physiological function of the hormone or hormones involved. Further fractionation experiments are in progress.

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CERTAIN BIOLOGICAL EFFECTS OF HIGH FREQUENCY FIELDS

BIOLOGICAL utilization of the electromagnetic spectrum has only recently spread into the region between radio and infra-red rays, with promise of revealing a useful field. The material and methods used in the present study have some advantages in outlining the problems to be taken up in a subsequent detailed analysis of the biological effects of this physical force.

A preliminary survey of the individual variation in response of *Habrobracon juglandis*, a parasitic wasp, to the same dosage in a high frequency electrostatic field is here reported. Exposure was made at 3.5 meter wave-length and auxiliary circuit current of 1.8 amperes.

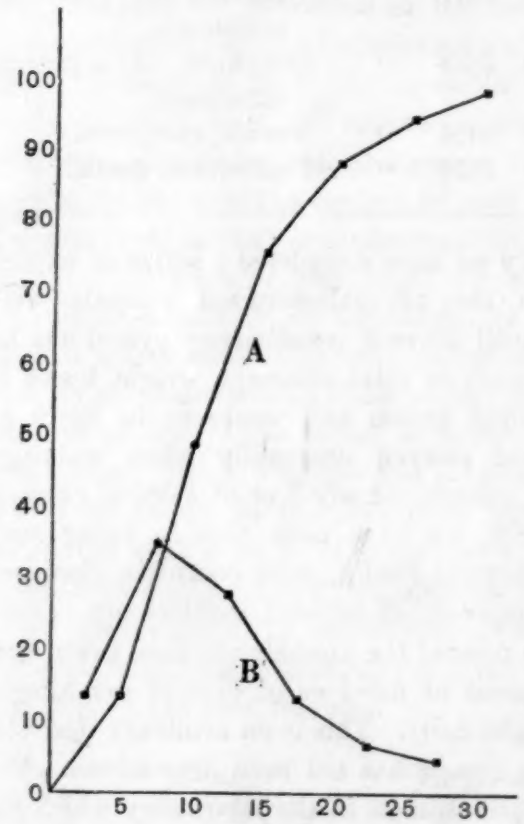

FIG. 1

Abscissae represent time of exposure in seconds; ordinates, per cent. of exposed wasps dead after twelve hours.

Material, nearly random as to age, sex, condition of feeding and metabolic state, as determined by temperature at which wasps have been kept, was used.

Wasps placed together in the field for the same length of time may be apparently lifeless, normal or in any intermediate condition at the end of the exposure.

Effects of the field were measured by lethality, which can not be determined immediately, since apparently lifeless individuals may recover, and normals die, within the first few hours after treatment. Groups of ten to fifteen were exposed together, and counts of living and dead were made twelve hours later when individuals could be assigned definitely to either group.

Curve A shows totals of such counts, expressed as percentage of total exposed which were dead after twelve hours, treatments being for five, ten, fifteen, twenty, twenty-five and thirty seconds. Curve B shows the increase in lethal percentage at each dosage over that of the next smaller exposure; it expresses the percentage of individuals expected to die within $\pm$ 2.5 seconds of each exposure time. The average time for death was 11.41 $\pm$ .09 seconds of treatment. The coefficient of variability was 56.27 $\pm$ .74 per cent., determined from 2,159 wasps.

An attempt is being made to determine any possible part age, sex, feeding and metabolic state may play in the wide range of individual susceptibility to the high frequency field, first observed by others in mice, by testing the range of variability under the action of each factor separately, the other three being kept constant.

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BOOKS RECEIVED

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